NSG 567-A

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1. PION LIFETIME
(R. Welsh, M. Eckhause)

Preparations are proceeding for a cyclotron experiment to be performed at Carnegie Institute of Technology to measure the mean lifetime of the positive pion. Previous measurements of this lifetime have been performed by photographing scintillator pulses on an oscilloscope. We will use the William and Mary 100 Mc digital timer to perform this measurement which should allow us to collect approximately one hundred times the events previously measured with corresponding increase in accuracy.

2. LIFETIME OF CO^{57} (14 KeV)
(R. Welsh, M. Eckhause)

The 100 Mc digital timer is being used in the laboratory to measure to high accuracy the lifetime of the 14 KeV state in Cobalt 57. This measurement will thus serve as a standard check of the timing apparatus for future measurements. Present accuracy of the Co^{57} lifetime is 3-4%, and we hope to improve the accuracy by an order of magnitude.

3. MESIC X RAYS
(R. Welsh, M. Eckhause)

A program for the development of large lithium-drifted geomanium detectors is planned. These detectors are necessary for accurate measurement of muonic X rays. We plan to measure muonic X ray energies in those elements in which we have measured the muon disappearance rate so that accurate determination of the charge radius as gained from muonic X rays will allow more complete interpretation of the muon capture interaction.

4. EXPERIMENTAL MUON CAPTURE RATES IN COMPLEX NUCLEI
(M. Eckhause, R. Siegel, R. Welsh)

During the summer of 1964, we measured the capture rates of negative muons in some 20 elements, using a 45-Mev muon beam at the Carnegie Tech synchrocyclotron. Together with previous runs, this has brought the total number of such capture measurements to 45.

Since that time we have been analyzing our data with a view to the following:

(1) to test the predictions of the Primakoff formula for muon capture rates over a wide range of atomic numbers.

(2) to see if one can learn something about nuclear structure.

(3) to ascertain whether other models, e.g., Fermi gas fit, can successfully account for the experimental results.

(4) to test the sensitivity of our data to several computations of the effective charge distribution of the nucleus.

We have obtained tentative results on some of the above questions.[1] Several striking features appear:

(1) A Primakoff fit to our data is markedly improved if one uses a nuclear charge distribution that is peaked at the edge of the nucleus. This may constitute evidence that those protons near the outside of a nucleus contribute most to the capture of muons. This possibility has been suggested by several theorists, including Foldy and Wolfenstein.

(2) A Fermi-gas fit, with relativistic corrections, has resulted in good values for the average neutrino energy and for the average capture rate by a proton.

Further refinements in our analysis will be made and we hope to have this entire program completed in the next several months.

[1] M. Eckhause, R. T. Siegel, R. E. Welsh, T. A. Filippas, and P. Palit, Bull. Am. Phys. Soc. 10, 80 (1965).

5. LIQUID HELIUM SCINTILLATION DETECTORS
(J. Kane, R. Siegel)

In an attempt to further specify the properties of a liquid helium scintillation counter, a measurement of the scintillation decay time has been made. Anode output pulse shape F(t) was studies in terms of the related superposition integral.

$$F(t) = \int_0^t F(t')\ I\ (t'-t)\, dt'$$

where F(t') is the scintillation intensity assumed to be of the exponential form $\frac{N_o}{\tau} e^{-t/\tau}$, and I (t'-t) is the system response function. Since fast response was essential, the alpha-induced events were viewed by a 56 TVP phototube and the pulse outputs fed directly to a fast oscilloscope. A least-squares fit to the data was optimized with a value of $\tau = 6.2 \pm 1$ μsec for the scintillation mean life. This value reflects of course the fluorescent decay time of the organic wavelength - shifter. (diphenylstilbene) which is used to coat the walls of the liquid chamber.

Experience has shown that counter performance is adversely affected by the introduction of small amounts of impurities into the liquid helium sample. With the present "open" system the impurities of the air eventually take their toll. We have now brought to the fabrication stage the only sure remedy to this problem, namely a closed gas handling and purifying system.

A circulating pump passes impure helium gas through two activated charcoal traps and a liquid helium coldfinger. Purified, the gas is then stored at 1 atm in a 400 liter tank. Counter operation commences once this supply is condensed into the precooled target volume. When the rare isotope He^3 becomes available, the use of a helium coldfinger will have the added advantage of reducing the β-active tritium impurity level by many orders of magnitude.

Preliminary work on the operation of solid state detectors in a liquid helium environment has been carried out. We hope to be able to detect the scintillation light of the liquid directly and eventually to improve upon the detection efficiency of the present photomultiplier arrangement. For these tests an alpha source is mounted in a small waveshifting chamber designed to accommodate a surface barrier silicon detector. Supported by the signal cable this chamber is suspended in the liquid of the counter reservoir.

Nonuniformity of pulse height (approximately 30%) in the small 2" diameter helium counter has lead us to favor a two phototube arrangement for viewing the sensitive target cylinder. Such a counter has been designed and commercially fabricated. Its recent arrival has initiated a new phase of activity. Whereas the small single phototube counter presented 0.125 liters of liquid to a cyclotron beam, the new counter with its two 5" diameter synthetic sapphires windows can maintain a sensitive volume of 2.8 liters. Nonuniformity of pulse height is estimated to be less than 5% over the entire target. One of the prime applications of this large counter involves the measurement of neutron emission asymmetry following the nuclear capture of polarized negative muons. A preliminary study of μ^- decay electron asymmetry will measure the degree of μ^- polarization and determine the feasibility of the neutron measurement.

6. MAGNETIC FIELD CORRECTION OF SREL 600 MEV CYCLOTRON (R. T. Siegel, H. Funsten)

Following earlier suggestions, (WHEN-7, College of William and Mary unpublished Report, August 1964), it was decided by Langley Research Center to shim or correct the magnetic field of the 600 MeV cyclotron in order to attain azimuthal symmetry to one part in 10^4. The original measurements on the field indicated field bumps of 90 gauss, or about one part in 200 non-uniformity. Following extensive computational effort, the field was corrected during December 1964 - January 1965. During this period the above-mentioned members of the High Energy Group served as advisors and consultants, in cooperation with representatives of the other VARC institutions.

The magnetic shimming program was successful, first and second harmonic field components now being $< 10^{-4}$, and maximum field error ~ 3 gauss.

7. BEAM STUDY INSTRUMENTATION
(M. Eckhause, R.T. Siegel)

In order to prepare for experiments with the cyclotron, certain specialized apparatus is being constructed for beam probing. This includes modular spark chambers for physical location of the beams in space, the special scintillation counters for beam quality study. The modular spark chambers will be coupled to a pulse-height analyzer for rapid -read out of beam range and position data. The scintillation counters will be used for studies of beam quality by means of nuclear interactions (pion "star" counters), and for a mass analysis by time of flight measurement of large area (8" x 8") beams.